MAGENT POWER SUPPLIES PERFORMANCE AT THE PLS-II STORAGE RING*

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Abstract

Magnet power supplies (MPS) are beam operating unipolar (bending, main-quadrupole, sextupole and septum) and bipolar (corrector, aux-quadrupole and skew) at the PLS-II storage ring (SR). Unipolar MPSs have to maintain stability during beam operation. Bipolar MPSs have to maintain stability and resolution including zero-crossing during beam operation. Slow and fast corrector MPS have good transient characteristic for beam orbit correction. In this paper, we present the improve activity and performance of the PLS-II SR MPS.

ONE CELL LINEAR LATTICE OF THE PLS-II SR

Lattice of the Storage Ring at the Pohang Light Source-II (PLS-II) has a gradient dipole double bend achromat (DBA) with twelve cells. At half-section of each cell, one gradient, four quadruple and four sextupole magnets are arranged as shown Fig. 1. Bending magnet has main bending winding(BD) and trim winding(TR), quadrupole magnet has main quadrupole winding(MQ) and auxiliary quadrupole winding(AQ), and sextupole magnet has main sextupole winding(ST), vertical(VC), horizontal(HC) and skew winding(SK). Fast corrector magnet is allocated up-stream and down-stream of each cell.

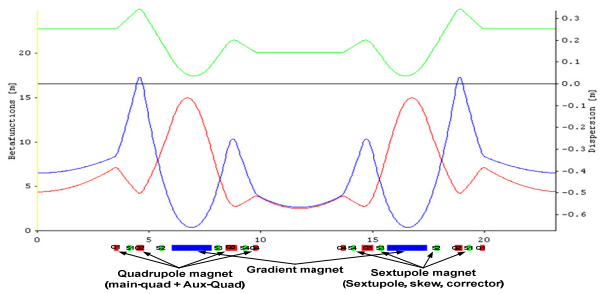

Figure 1: One cell linear lattice of the PLS-II SR.

MPS OF THE PLS-II SR

Unipolar MPS

Twenty-four BDs, same series twenty-four quadrupole magnets (MQ1, MQ2, MQ3 and MQ4) and same series twenty-four sextupole magnets (ST1, ST2, ST3 and ST4) are series connected by each one unipolar power supply, respectively. Septum magnet is individually connected with unipolar power supply. Unipolar MPSs for bending (BD), main-quadrupole (MQ), sextupole (ST) and septum (SP) magnet are parallel operation type of unit stack buck type power supply. Unit stack of unipolar MPS has capability maximum 250A and operation 10 kHz. BD and MQ MPS are adopted four stacks as 90-degree phase shift switching of each stack, and have capability maximum 1000 A. ST MPS is adopted two stacks as 180-degree phase shift switching of each stack, and have capability maximum 500 A. SP MPS is adopted single stack, and have capability maximum 250 A. Table 1 lists main specifications of unipolar MPS [1].

Bipolar MPS

Bipolar magnets of each cell are same allocation. Vertical and horizontal corrector PSs are connected at corrector winding of sextupole magnet, and skew PS is connected at skew winding of first and last each cell sextupole magnet. Aux quad and Dipole trim coil PS are connected at trim winding of main-quadrupole and dipole magnet. Fast corrector PS is connected at fast corrector magnet of up and down stream, each cell straight section. All bipolar MPSs are consisted as same H/W configuration for easy maintenance. Maximum output current of bipolar MPS is +/- 20A. Table 2 lists main specifications of bipolar MPS [2].

Table 1: Main Specifications of Unipolar MPS

MPS	BD	MQ	ST	SP
AC input (Δ/Y)	470/470	400/400(1,2,4) 460/460(3)	440/440	30/30
output[A]	1000		500	250
Stack PS	four		two	single
output[V]	528	394(MQ1,MQ4) 497(MQ2) 662(MQ3)	409(ST1) 473(ST2,3,4)	28.3
Main circuit	12-p diode rectifier Phase shifted switching of buck converter			
Stability	+/- 10ppm fwhm, long term			
controller	Full Digital, ADC: 18bit Embedded EPICS IOC			

Table 2: Main Specifications of Bipolar MPS

	AQ	SK	VC/HC	FC(V/H)	TR
No.	96	24	Each 96	each 48	24
input[Vac]	30	15	30	30	15
Output[Vdc]	**+/- 20**				
circuit	H-bridge type				
Stability	+/- 10 ppm, Long term				
Controller	Full Digital, ADC: 18bit Slow: embedded EPICS, fast: high speed RS422				

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PERFORMANCE OF MPS

Unipolar MPS performance measurement

For precision performance measurement of unipolar MPS, the experimental set-up is installed as shown Fig. 2. And, the specification of the installed experimental set-up is listed at Table 3.

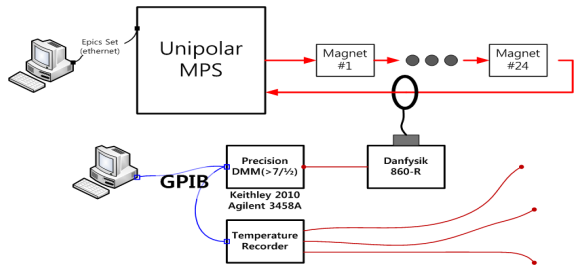

Figure 2: Measurement diagram of unipolar MPS.

Table 3: Specification of Current Measurement Set-up

Current Transducer (Danfysik 860R)	
Linearity	< 3ppm
Stability (Vs. Temp.)	≤ 2ppm/ ℃
Stability (Vs. Time.)	≤ 2ppm/month
Precision DVM	
Accuracy	0.6ppm
Stability	4ppm (year)

Long term stability performance is influenced by environment temperature. BD and MPS MPSs are installed at MPS building of the SR outside. In order to reduce orbit drift effect by main MPSs, output current of the BD MPS and room temperature are measured and analyzed. BD MPS output current is changed by room temperature change and air flow from cable tunnel of underground. After room temperature thermostat improvement and blocking air flow from underground tunnel, output current of BD and MQ MPSs are stabilized during one day. Fig. 3 shows stability improvement result of BD MPS. Fig. 4 shows MQ MPS output current stability. Sextupole MPSs are installed at control shed of the SR. Table 4 listed long term stability results of the unipolar MPS. Stability of BD, MQ and SP MPS was measured below than +/- 10mA. And ST MPS was slightly high than +/- 5mA.

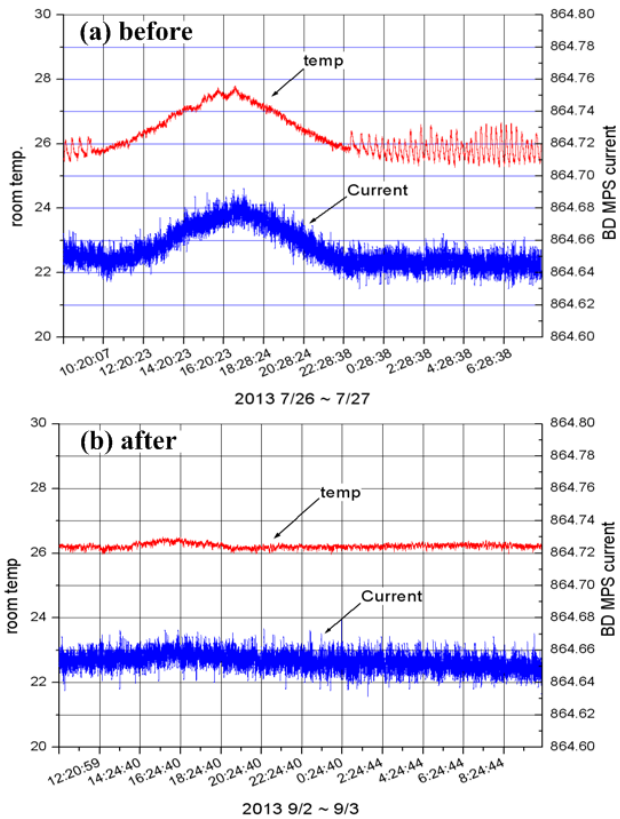

Figure 3: Stability improvement of BD MPS.

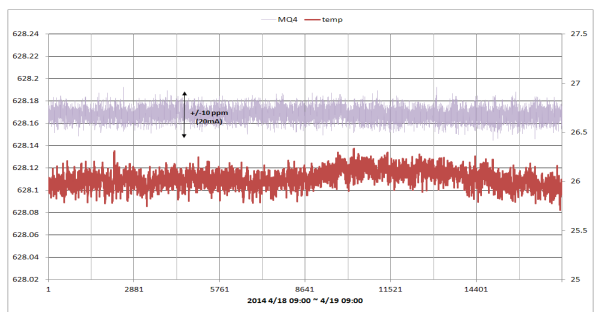

Figure 4: Stability of MQ4 MPS.

Table 4: Stability of Unipolar MPS

MPS	Long term Stability operation[A]	
BD	864.71	
MQ1	557.95	
MQ2	811.21	< +/-10 mA
MQ3	663.17	
MQ4	617.4	
ST1	228.6	
ST2	290.0	
ST3	282.9	< +/-5mA
ST4	268.5	
SP	188.7	

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Bipolar MPS performance measurement

To verify operation performance of bipolar MPS, various kinds of experimental test for zero-cross characteristic, resolution, reproducibility and stability are performed. Fig. 5 shows performance measurement setup.

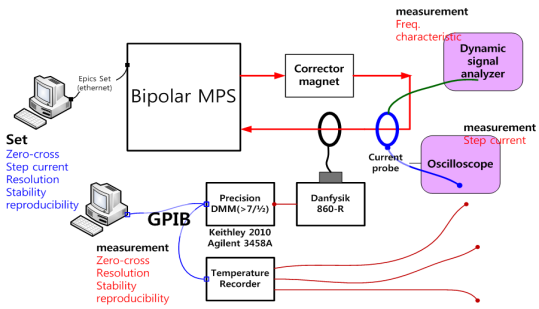

Figure 5: Performance measurement setup of bipolar MPS.

Slow and fast corrector MPS are controlled from orbit feedback system. Therefore, resolution, step transient and stability have to do good performance at bipolar MPS. Normal controlled values of horizontal and vertical corrector MPS are within +/-6 mA and +/- 2 mA of previous value during slow orbit feedback operation, respectively. Therefore, resolution test is performed as 0.1mA step. Fig. 6 and 7 show resolution of slow and fast corrector MPS.

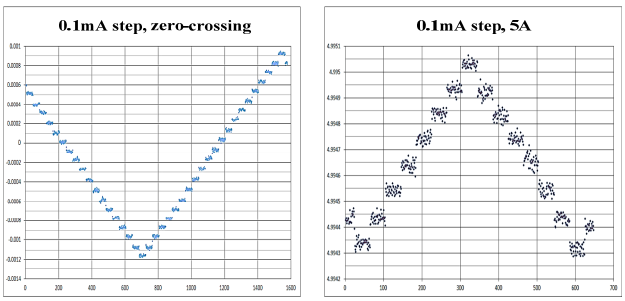

Figure 6: Resolution of slow corrector MPS.

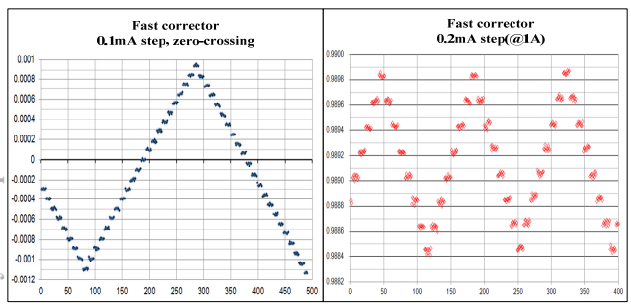

Figure 7: Resolution of fast corrector MPS.

Slow and fast corrector MPS are operating within 1mA stability. Fig. 8 shows stability of slow and fast corrector MPS. Rising time of slow corrector is 22ms/10A. Fast corrector MPS has to do fast rising characteristic for fast orbit feedback operation. Rising time of fast corrector MPS is 360μs/2A. Table 5 lists performance summary of bipolar MPS.

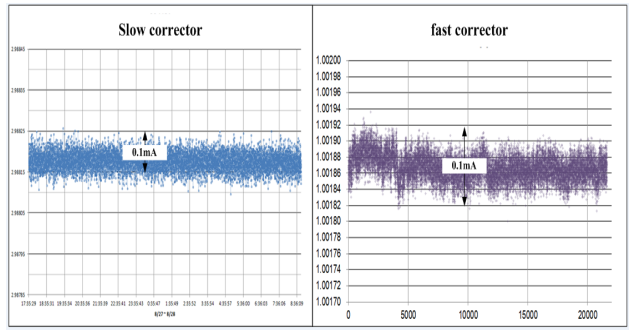

Figure 8: Stability of slow and fast corrector MPS.

Table 5: Summary of Bipolar MPS Performance

	Slow corrector	Fast corrector	Remark
stability	0.1	0.1	mA
Resolution	0.08	0.08	mA
reproducibility	+/-0.05	+/-0.05	mA
Control interface	epics	RS422 (2.7Mbps)	

SUMMARY

Unipolar (BD, MQ, ST, SP) and bipolar (slow corrector, fast corrector, AQ, skew and others) MPSs are beam operating as required specification at the PLS-II SR. Fast and slow orbit feedback system is beam operating from 2016 user service. RMS orbit maintain within 1μm during 10 day beam operation.

REFERENCES

[1] S. Kim, "Low Current Bipolar Magnet Power Supply at the PLS-II Storage Ring", proceeding of IPAC2012, pp. 3635-3637.

[2] S. Kim, "High Current Unipolar Magnet Power Supply at the PLS-II Storage Ring", proceeding of IPAC2012, pp. 3638-3640.